solplan review

the independent newsletter of energy efficient building practice

the drawing-room graphic services ltd.
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No. 21 June—July 1988

INSIDE....

Effective, economical insulation that is easy to install properly is desired by everyone. Radiant barriers deal with radiant heat transfer - and reduce summer overheating of houses. In this issue we review what they are, how they work, and where they are suitable. As profit margins are high, you may encounter slick marketing campaigns (as is already happening in the US) - but they are not suitable in all northern climates.

Dave Read reports on the results of a residential retrofit project in Cranbrook, B.C. The work was documented and tests carried out. Of interest was the discovery that by insulating the interior partitions as well as outside walls (with blown cellulose insulation) the airtightness was substantially improved.

Blower door testing of houses tells us how tight the house is. However, if there are holes, it is not always easy to identify their location. Peter Moffat presents an approach using an infra red scan along with the blower door to quickly pinpoint leakage areas.

Other items include a review of ventilation monitoring, proposed changes to ventilation requirements in B.C. and a commentary about the stand the mechanical equipment manufacturers are taking on legislated equipment efficiency rating.

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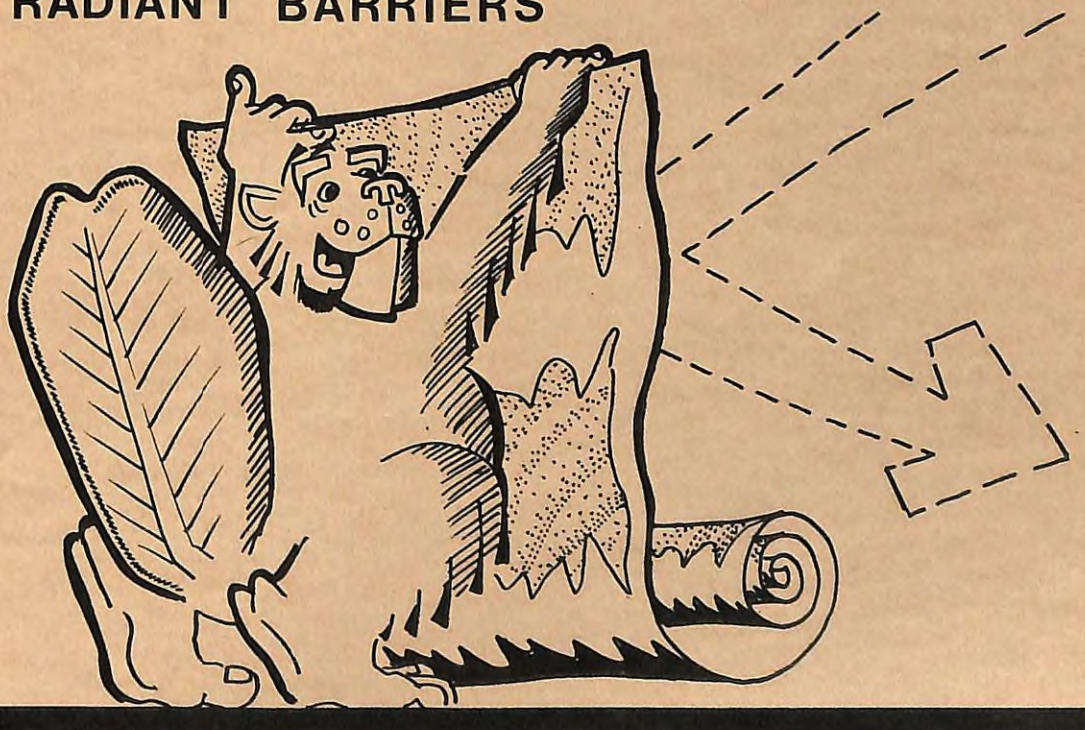
Richard Kadulski

RADIANT BARRIERS



FROM THE PUBLISHER

Regular readers are aware that our goal is to provide coverage of issues related to low energy building technology. SOLPLAN REVIEW is an independent technically up-to-date journal serving the needs of builders and designers of quality housing.

SOLPLAN REVIEW is now the only Canadian publication exclusively devoted to the technical concerns of the residential building community.

We are an independent, subscription supported publication now in our 4th year. Our policy has been not to swamp editorial content in a sea of advertising, nor be subject to the pressures of an advertiser supported controlled circulation paper, but we do accept a modest amount of advertising.

Regular readers will note that with this issue we have expanded our advertising section, in order to help offset the costs of a wider distribution to many prospective first time readers. The result of this experiment is in the hands of the new readers. If you are seeing this publication for the first time or have looked at it and have not yet gotten around to subscribe, but find it useful, why not do it today? That will ensure you continue receiving it. We can't send it out to non-subscribers forever!

We look forward to your continued support. There are many exciting developments coming that I am sure you will want to read about in the near future.

Richard Kadulski
Publisher

ODDS 'N ENDS

* National Heating Ltd. the distributor of ESWA electric radiant panels has undergone a corporate reorganization. It will now be known as **ScanCan Industries Corp.** to handle distribution of ESWA products in B.C. and Alberta. They're at 1450 Kootenay St, Vancouver, B.C. V5K 4R1 Tel. 299-0775.

* As part of the transfer of the R-2000 Program to the industry, Energy Mines and Resources Canada is taking a lower profile in the R-2000 Program. As a result, Charles Ficner, director of the Super Energy Efficient Housing Program (R-2000), a key technical person in the development of the Program, has been reassigned.

* Cold weather (-40°C) testing of heat recovery ventilators is now underway at the Ontario Research Foundation. Results for the first several units should be available soon. This is of special interest to the far north, where meeting ventilation needs efficiently is important - not just heat recovery efficiency but low power consumption also (electric costs can easily run up to $0.80 per Kwhr).

* A cellulose blown-in-batt insulation is now approved for use in Alberta. CMHC approval is pending field tests. The benefits of this approach to insulation is that it can provide an even insulation placement. It overcomes problems of poor installation of batt insulation around service wires and conduits. Similar products have been in the US for several years.

Rational Use of Energy - International conference and trade show. Buenos Aires, Nov. 21 - 25, 1989. Objectives are to exchange information on experiences and technological changes on the appropriate use of energy (including alternative sources). Housing and construction is one of many sectors to be covered. Presentations are solicited. Information: AAPURE, San Martin 663, Piso 9D, Buenos Aires 1004, Argentina.

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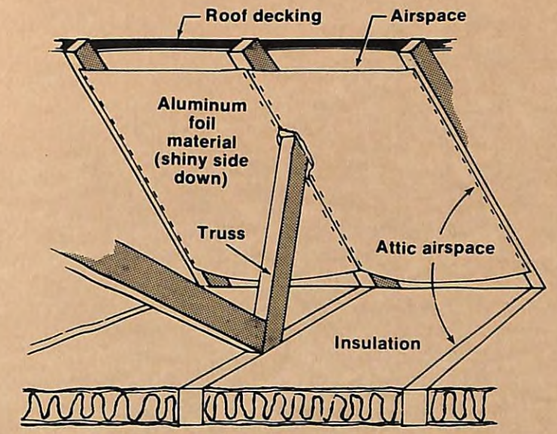
RADIANT BARRIERS

Radiant barriers are an energy conservation concept being heavily promoted in the United States. Used in more northerly locations, they improve a home's comfort during the summer and reduce cooling loads. However, they must be installed correctly or else they may contribute to structural damage.



An installed radiant barrier.

WHAT IS A RADIANT BARRIER?

A radiant barrier is a layer of highly reflective foil placed in an airspace to block radiant heat transfer between a heat-radiating surface (such as the hot roof) and a heat-absorbing surface (such as conventional attic insulation).

Without a radiant barrier, the roof radiates solar-generated heat to the insulation below it. The insulation absorbs the heat and gradually transfers it to the material it touches - principally, the ceiling. This heat transfer makes your ceiling a low temperature radiant heater that heats the indoor space. Where air conditioners are used, this heat adds to the load the air conditioner has to deal with.

Foil radiant barriers can block 95% of the heat radiated by the roof so it can't reach the insulation.

Radiant heat flows are only one of three means by which heat flows. Conduction and convection are also significant heat flow mechanisms, so the ideal insulation scheme will address all three.

HOW DO RADIANT BARRIERS "BLOCK" HEAT TRANSFER?

Aluminum foil, the operative material in attic radiant barriers, has two physical properties of interest. First, it reflects thermal radiation very well. Second, it emits (gives off) very little heat. In other words, aluminum foil is a good heat reflector and a bad heat radiator.

Aluminum foil across an attic airspace reflects heat radiated by the roof. Even if the radiant barrier material has only one aluminum foil side and that side faces down, it will still stop downward heat transfer because the foil will not reradiate the roof's heat to the insulation below it.

WHAT KIND OF RADIANT BARRIER MATERIALS ARE AVAILABLE?

1. Single-sided foil backing on another material such as kraft paper or polypropylene.

2. Double - sided foil with a reinforcement backing (sandwiched between foil layers).

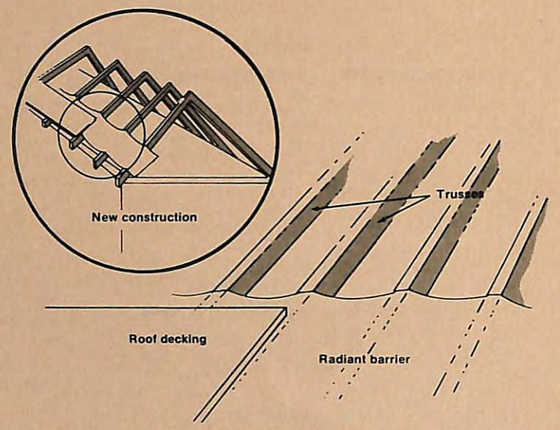
3. Foil-faced insulation. The insulating material may be polyisocyanurate, polyethylene "air-bubble" packing or other materials that impede heat conduction.

4. Multilayered foil systems, which when fully extended and installed so that the foil layers do not touch. These products also form insulating airspaces.

WHICH IS BEST?

The best, most effective material to use is the cheapest material that will do the job. Unlike regular insulation, when used in combination with conventional insulation the radiant barrier does not have to be applied with complete coverage to do its job. Special, high tech products generally are more expensive but not much more effective. Standard builder's foil (or even household foil) will do a good job.

A single-sided radiant barrier will at first work equally well with the foil



Radiant barrier installation in new construction.

facing up or down. However, over time dust will accumulate on the surface of foil facing up. The dust will reduce the radiant barrier effect by allowing the foil to absorb rather than reflect heat. But a radiant barrier with the foil side facing down will not collect dust on the foil and will continue to reduce heat transfer from the hot roof to the insulation over the life of the installation. So in attics, single-sided radiant barrier material should be installed with the foil side facing down.

Where double-sided radiant barrier material is used, it must be installed at the rafter level so the bottom side faces the attic air space and will not collect dust.

The most effective way to install a radiant barrier is to staple the foil material to the underside of the top chord of the roof trusses or to the underside of the roof decking. In an attic with a pitched roof and conventional insulation, a radiant barrier is not difficult to install even in a retrofit situation. However, a radiant barrier must never be installed flat on top of insulation, as that will create a vapour barrier on the cold side of insulation.

DOES THE RADIANT BARRIER HAVE TO BE AIRTIGHT?

No, as it is a barrier against radiated (not convected) heat, air motion does not have to be stopped. In fact, ventilation from soffit to peak will improve radiant barrier performance.

Small tears and holes will not lessen the performance of the radiant barrier, so if it is necessary to cut and patch around obstructions such as vent stacks, truss supports and other penetrations, it will still work.

The material must not be rolled out on top of the insulation. As dust will accumulate on the foil surface facing the roof, it will lessen the radiant barrier effect. But more importantly, this kind of installation will create a vapour barrier on the cold side of the insulation and result in moisture being trapped in the ceiling insulation. You have been warned twice!

WILL HEAT IN THE ROOF DAMAGE THE ROOFING?

It's extremely unlikely. The Florida Solar Energy Centre has measured the tempe ratures of roof shingles above attic radiant barriers on hot, sunny summer days. Depending on the colour of the shingles, their peak temperatures are only 1-3°C (2-5°F) higher than the temperature of shingles under the same conditions without a radiant barrier.

Roofing materials are manufactured to withstand the high temperatures to which they are frequently exposed. A 1-3°C (2-5°F) increase in peak temperatures that normally reach 71-87°C (160-190°F) should have no adverse affect.

Be aware, however, that accumulated heat from a sub-roof plenum may cause built-up tar and gravel roofing to shrink. If sufficient shrinkage occurs, the water seal may be broken at flashings or elsewhere.

HOW MUCH CAN RADIANT BARRIERS SAVE?

Economy depends on the characteristics of the house and its occupancy. Savings from an attic radiant barrier depend on the amount of heat the roof and attic contribute to home's cooling load.

Computer studies conducted in the development of the Florida Model Energy Code indicate savings on cooling costs can typically be up to 8 - 12%. A typical attic radiant barrier installed in a Florida home will offer a six to seven year simple payback and a 15% to 19% return on investment.

Attic radiant barriers are an inexpensive but effective way to save energy and money in cooling conditions. While they are not a new concept, radiant barriers have only recently been proved effective for energy conservation.

Unfortunately, the high profit potential has led to exaggerated claims for radiant barriers. It is likely we will hear these claims in Canada soon. Many distributors in the USA are promoting radiant barrier products as the only insulation needed for use in walls as well as ceiling installations. Properly used this may be effective in the hot southern climates.

In northern heating climates this is not as likely to be suitable. Improper installation can actually be counterproductive. Some 20-30 years ago multi-layered foil insulation (for walls) was promoted on the Prairies. It was quickly abandoned as the foil layers provided ideal channels for convection currents, and the walls actually cooled the house rather than contributing to the insulation properties.

In our northerly locations, combining a radiant barrier with an R-2000 home will improve the home's comfort, and even eliminate the need for mechanical air conditioning.

*This article was adapted from **Radiant barriers** an energy note by Ingrid Melody of the Florida Solar Energy Centre.*

CRANBROOK, B.C. RESIDENTIAL RETROFIT - A CASE STUDY

In September 1987, Energy Conscious Design undertook a major retrofit of a single family home in Cranbrook B.C. (4807 DD°C). Part of the project included a three day workshop for contractors to learn effective retrofit techniques by hands-on participation.

The house has 1190 sq.ft. on the main floor, and 1150 in the basement. The total building area was heated before and after the renovation.

The house had 2x4 frame walls with R12 insulation and R20 in the ceiling. The foundation was concrete with R12 on the basement walls. Some windows were aluminum sliders, others sealed wood frame. In winter the house was drafty and dry. The construction offered unlimited air leakage points to challenge our air sealing efforts including poured-in-place floor joists, metal and masonry chimneys, recessed pot lights, cantilever, as well as the usual assortment of electrical penetrations, plumbing, vent stacks and attic hatch.

The objectives of the retrofit were three-fold:

1. To reduce the winter fuel consumption. The home had at one point been heated exclusively by electricity (at current prices, this cost $1200 per year). It was recently being heated mainly by wood with some supplementary electric heating. Wood usage exceeded six cords per year.

2. To improve comfort. The home was deficient in this area due to the high air leakage rates.

3. To improve indoor air quality. While there was no lack of fresh air, there was always a lack of moisture, with winter relative humidity running at 15% to 20% despite attempts to increase it.

Main Floor Walls:

The original siding was removed to expose the wall sheathing. This allowed a thorough inspection which revealed many air leakage paths. The worst were at the floor joist level. There were large gaps where rim joists butted and between rim joist and subfloor or subfloor and bottom plate. Leaks were also evident through the cantilevered floor and through butt joints in the aspenite sheathing. These large gaps also allowed easy entrance for insects.

Air sealing of the walls was accomplished by a complete wrap of Tyvek which bridged from the top of the concrete foundation to the top plate of the main floor wall. All joints were caulked with acoustical sealant or taped with sheathing tape and all service penetrations were gasketted with rubber sheets. This approach was easy to do and proved very effective.

Most of the wall was upgraded by installing a curtain wall on the outside to create a six inch cavity for insulation.

TYVEK wrap, nailer for curtain wall, sealed to foundation.

Curtain wall in place, entry light extension.

This was then blown with R-20 cellulose insulation for a new total R-value of 32. This installation was achieved smoothly.

For comparison some wall areas were insulated with R-10 Styrofoam sheathing and some with R-7.5 Styrofoam. While no problems were encountered in the installation the increase in R-value was much less than for the curtain wall.

Table 1. compares the cost per square foot for materials for the curtain wall or the Styrofoam.

TABLE 1. WALL RETROFIT COMPARISON

CURTAIN WALL	
ADDITION OF R20 INSULATION	
TYVEK (225 SQUARE FEET AT 12 CENTS/SQ.FT.)	$ 27.00
2x4 STUDS (20x9') PLUS 280' LEDGERS & PLATES 280' @.22	61.60
½" PLYWOOD (½" SHEETS @ 10.94)	5.50
¼" ASPENITE (7 SHEETS @ 7.69)	53.83
BLOWN CELLULOSE INSULATION R20-225 SQUARE FEET @.45	101.25
SUB-TOTAL	$249.18
NAILS, CAULKING, TAPE, PLUMBING & ELECTRICAL & WINDOW EXTENSION ADD 10%	24.92
TOTAL	$274.10
FOR 225 SQUARE FEET COVERAGE = $1.22 PER SQUARE FOOT	

INSULATING SHEATHING	
ADDITION OF R10 (2" STYROFOAM)	
TYVEK (225 SQUARE FEET AT 12 CENTS)	$ 27.00
2x4 LEDGER (25' @ 22 CENTS)	5.50
R10 STYROFOAM (225 SQUARE FEET @ .87 CENTS)	196.73
1x4 STRAPPING (126' @ 12 CENTS)	15.12
SUB-TOTAL	$244.35
NAILS, CAULKING, TAPE, ETC. 10%	24.44
TOTAL	$268.79
FOR 225 SQUARE FEET COVERAGE= $1.19 PER SQUARE FOOT	

Labour costs for the two systems were also very similar. This may seem surprising at first since the installation of the Styrofoam boards is so simple. However, in order to install vinyl siding over the two inch Styrofoam, it is necessary to strap with 1x4. And while installation of the curtain wall may appear more complex, it is in fact very simple.

Foundation walls:

Foundation walls were insulated from the outside with R10 Styrofoam to a depth of two feet below grade. The Styrofoam was attached with mechanical fasteners. Above grade the insulation was protected with Dow Foundation Coat, a parging material applied before backfilling. This coating, which is brushed on, was found to be very easy to work with, even for relative novices. The major problem was a difference in colour between batches which may require painting to achieve a uniform appearance. Total material cost for the insulation above grade was $1.68 per square foot (half of that for below grade as no fasteners or parging are necessary).

TYVEK air barrier wrapped under cantilever and sealed to concrete foundation.

Doors and Windows:

Both entrance doors were changed to insulated steel doors with Schlegel Foam-Guard weatherstripping. A metal frame patio door was changed to wood frame with Low-E glass. Three aluminum slider windows on the main floor were changed to wood frame units with Low-E glass, and all sizes were increased. Seven aluminum slider windows in the basement were upgraded to triple with the addition of 3M "Stretch and Seal" plastic storm windows. These are very low cost and proved easy to apply and effective in reducing air leakage and increasing insulation value.

Attic:

Attic air sealing prior to adding insulation is a most important part of any retrofit project. The existing fiberglass batts were moved to allow this work to be done. Gypsum board boxes were constructed and sealed over the recessed light fixtures. The large leaks around the masonry chimney were sealed with gypsum board and expanding foam. Outlet boxes were sealed from either above or below the ceiling. A major leakage area was determined to be through the interior partitions and into the attic. This was eliminated by blowing the interior partition walls with cellulose insulation. It was one of the single most effective measures used in this project.

Air barrier boxes built in place over recessed light fixtures.

After air sealing and replacing the batt insulation, additional cellulose insulation was blown in to achieve a new total R40 .

Air Leakage Tests:

To monitor progress and measure the results of the air sealing work several leakage tests were done using a Retrotec Calibrated Blower Door.

The initial test confirmed how leaky the house was. The original house measured at 7.0 air changes per hour (ACH) at 50 pascals depressurization and 198 square inches of leakage area. Natural air leakage was estimated at 0.42 ACH.

The second test was done after doors and windows were changed, Tyvek was on but not sealed at openings and the attic was sealed except for interior partitions. Results were 4.5 ACH at 50 pascals, 138 square inches leakage area and a natural leakage rate of .27 ACH.

The third test was done after cellulose insulation was blown into the interior partition walls. Results of this test were 2.72 ACH at 50 pascals, 76 square inches of leakage area and natural leakage of .16 ACH.

The fourth test was done after most of the Tyvek was sealed and the attic insulation had been blown. Results were 2.65 ACH at 50 pascals, 61 square inches leakage area and natural leakage rate of .11 ACH.

The last test was done after the Tyvek was completely sealed, basement windows retrofitted and all residual leaks sealed. The results were 1.95 ACH at 50 pascals, 48 square inches equivalent leakage area and natural air change rate of .09 ACH.

Compared to the initial test, natural air leakage was reduced by 79%!

The achievements in air sealing were far better than anticipated. While no effort can be overlooked in air sealing work, two measures clearly stand out in terms of effectiveness: the Tyvek wrap and the blowing of cellulose into the interior partitions.

Ventilation:

The indoor air quality deteriorated drastically following completion of the air sealing work. The air was noticeably stale and stuffy and the relative humidity was 65% to 70%. This was despite having four windows open at least an inch at all times.

This experience is not surprising considering the extent of the air sealing work done. It underlines the necessity of mechanical ventilation in energy efficient houses.

To supply the needed ventilation, a VanEE model 1000 heat recovery ventilator was installed. As the home has baseboard electric heating the installation required ductwork to all rooms to exhaust from the kitchen, each bathroom, and the laundry-workshop area and supply fresh air to all other rooms.

Ductwork layout was achieved easily by routing the ducts through closets to the main floor and using a combination of ceiling or high wall grills. Basement ducts were run above the suspended ceiling. The existing bathroom exhaust fans were disconnected and blocked off, but the existing kitchen range hood exhaust fan was retained to provide peak exhaust capacity for the kitchen.

The HRV installation was done carefully to ensure the ductwork would have low resistance. The installed air flow is measured at 120 CFM at high speed. This will provide 0.4 air changes per hour. It is normally operated at low speed which provides 70 CFM, which gives a constant .25 air changes per hour. Timer switches in each bathroom allow for a period of high speed operation following baths or showers.

Installation of the HRV produced an immediate improvement in indoor air quality. It has proven to be far more effective than opening windows as it provides a constant air flow. The air feels fresh and odours are efficiently removed. Relative humidity was immediately reduced to 40% to 50%. This is a comfortable and healthy level and has been effective in avoiding any problems with condensation on windows. The unit operates reasonably quietly although there is some motor noise on low speed. Electrical consumption has been monitored and is 56 kilowatt-hours per month ($2.52 at current rates).

Mechanical ventilation is now mandatory in new housing and should be part of any retrofit. However it must be stressed that heat recovery ventilators are not intended to provide combustion air to the wood burning heater.

Heating:

The home had existing baseboard heating and wood heating. So it qualified for the B.C. Hydro Electric Plus rate for heating. Conversion was simple, requiring only the installation of a second electrical meter and small sub-panel. This results in a 44% reduction in the rate charged for heating energy. The conversion would have been practical with or without the energy saving retrofit work.

(The Electric Plus program is a special interruptible program that offers a substantial discount on electricity used for space heating. It involves a separate meter, and penalty pricing for use of electricity for space heating during period of interruption).

Radon Testing:

An initial test prior to the retrofit work indicated a radon level in the home of 4 pico curies per litre, equal to the maximum safe level recommended by the U.S. Environmental Protection Agency. A subsequent test was done after retrofit and before installation of the ventilation system and a further test is underway with the ventilation system in operation. Results of the second and third tests are not yet available.

Costs and Benefits:

Table 2 summarizes the costs of the retrofit work:

TABLE 2 TOTAL COSTS

MATERIALS	
MAIN FLOOR WALLS:	$1196.37
FOUNDATION WALLS:	753.67
DOORS AND WINDOWS:	921.32
ATTIC:	675.00
AIR SEALING:	458.95
VENTILATION SYSTEM:	1336.69
	$5342.00
LABOUR COMPONENT (ESTIMATED)	3500.00
TOTAL	$8842.00

NOTE: DOOR AND WINDOW COST INCLUDES ONLY THE COST OF BASIC STEEL INSULATED DOORS AND ONLY THE COST FOR ADDING LOW-E GLASS TO WINDOWS.

The energy savings benefit of the retrofit measures is estimated to be 60%. Based on pre-retrofit energy cost of $1200 per year, savings will be $720 per year. This is a 13% annual return on investment on material costs or an 8% return if estimated labour costs are included. The

THE BOOKSHELF

A selection of books that will be of interest to our readers.

RADON: The Invisible Threat
by Michael Lafavore
Radon is a colorless, odorless and tasteless radioactive gas that finds it way into houses. RADON defines what it is, where it is found, how it can contaminate a house, and practical steps to overcome the problem in new construction or in existing homes.

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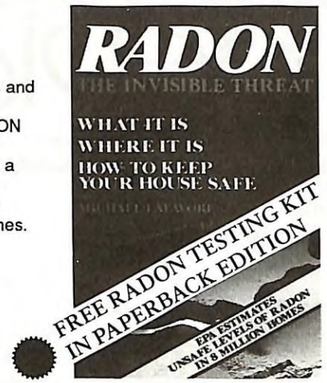

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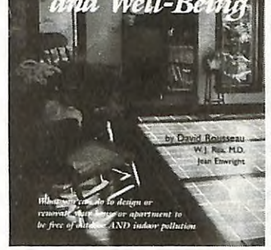

YOUR HOME, YOUR HEALTH, AND WELL BEING
by David Rousseau, W.J. Rea, Jean Enwright
What you can do to design or renovate your house or apartment to be free of outdoor and indoor pollution. By knowing what pollutants affect our homes, and applying carefully explained step-by-step solution, dwelling can be transformed into healthy, quiet clean pleasant places. A special detailed section gives recommendations for those with environmental sensitivities.

Paperback $19.95

SOLPLAN 5: Energy Conserving Passive Solar Houses for Canada
An introduction to low energy building, includes a summary of passive solar and energy conserving construction techniques, worksheets (in calculating solar gains and thermal storage), plus 21 house designs. pub. 1981

Paperback $5.95

SOLPLAN 6: An Air Exchanger for Energy Efficient Well Sealed Houses
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Dara Bowser
AirChanger Marketing, Mississauga, Ont.

I was delighted to have the information (in the latest issue)
Kim Krenz
Abrico Management, Lakefield, Ont.

I would like to compliment you on your ambitious undertaking of reporting on new developments in the dynamic energy efficient housing industry.
J.M.Bond
B.C.Hydro, Vancouver, B.C.

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I very much enjoy reading SOLPLAN REVIEW....Keep up the good work as there is certainly nothing better than a free and open exchange of ideas to improve our knowledge and understanding of the building construction process.
Donald E. Holte
Nova Engineering Ltd. Edmonton, Alta.

I have a copy of SOLPLAN REVIEW... and I see a lot of good things in it
Frank Kelley
Calgary Alta.

Your newsletter is an excellent publication
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NuTone Housing Group, Cincinnati, Ohio

RESIDENTIAL VENTILATION: Achieving Indoor Air Quality

The publication that tells designers and builders how to deal with indoor air quality issues.

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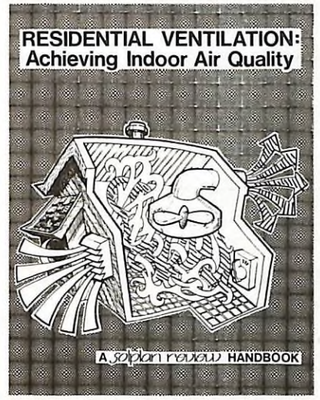
RESIDENTIAL VENTILATION: Achieving Indoor Air Quality describes **why** ventilation is necessary and **how** it can be provided, effectively and without creating resident discomfort.

Who should read this publication? This publication will be of special interest to builders and designers, however, it is written in simple language so that homeowners can also benefit from it.



CONTENTS

1. Indoor Air Quality why be concerned, when and where is it a problem?
2. Dealing with Indoor Air Quality control of pollutants, combustion appliances, moisture control, filtration, ventilation.
3. Ventilation System Design how to design a good ventilation system.
4. Ventilation Systems basic systems described: intermittent ventilation; continuous; exhaust only; supply only.
5. Codes and Standards what do codes call for, and how to comply.
6. Equipment Descriptions Description of typical ventilating equipment
7. Glossary of Terms
8. Sources of Information

Written by: **Richard Kadulski** *Architect, with many years experience in low energy construction; publisher* ***Solplan Review****, R-2000 instructor and design evaluator.*
Illustrated by: **Terry Lyster** *Illustrator of* ***Wintergreens****,* ***The Solar Water Heater Book****, the* ***Solplan*** *series of books. His drawings appear in the* ***Solplan Review****.*
Technical consultant: **David Hill** *president Eneready Products, a ventilation equipment distributor; National Building Code sub-committee member (Part 6: Ventilation)*

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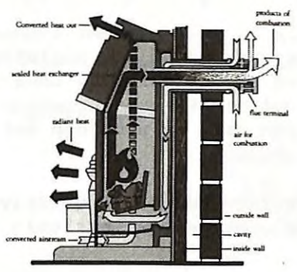

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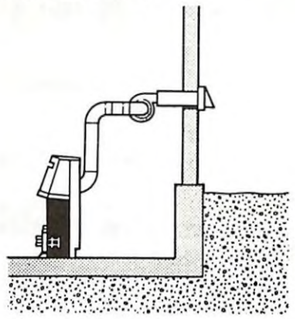

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payback is there but it will be lengthy.

Savings due to the Electric Plus conversion are not included in the above since costs were low and payback would be within a few months. Total annual heating costs using electric heating only are expected to be under $300.

No wood heating will be used for a twelve month period in order to accurately monitor actual costs. Actual heating costs for November 1987 to February 1988 are shown in table 3. The data indicates that costs are on track for an annual total of about $300. Heating costs have been determined from consumption on a separate meter which registers heating usage only. There has been no use of wood heating.

TABLE 3 ACTUAL HEATING COSTS

MONTH	ELECTRICITY CONSUMPTION (KWHR)	ELECTRICITY COST (@$.025/KWH)	MEASURED DEGREE DAYS (DD°C)
NOVEMBER* 1987	1365	$34.12	499 DD°C
DECEMBER	2340	58.50	789
JANUARY 1988	2550	63.75	852
FEBRUARY	1810	45.25	593
MARCH	1200	30.00	462
APRIL	640	16.00	290
MAY	320	8.00	198

* Monitoring started November 6, 1988. HRV not hooked up until early November

However, there are many benefits other than monetary and these must also be considered in establishing the "payback" of the project.

* The comfort objective has certainly been met with elimination of drafts and cold spots.
* Air quality is dramatically improved. The occupants would not wish to live in a home without a ventilation system again. Higher maintained humidity in the house makes it more comfortable and has proven to be healthier, yet humidity control is available to prevent condensation during cold weather.
* Sound control is greatly improved. The early morning logging truck traffic is no longer noticed on the road past the house. Interior sound control was also improved due to the blown insulation in interior walls.
* The insect population is now kept outside as the elimination of air leaks also seals off access routes for bugs.
* Aesthetics of the home were improved by the replacement and upgrading of the doors and windows.
* Value and saleablility are enhanced because the home has been updated to optimum energy efficiency.

Finished exterior with new siding over curtain wall, new windows with low-E glass and new insulated door.

There is no R-2000 designation for retrofitted homes so this house cannot be registered as an R-2000 home. However it will perform within the R-2000 energy budget and offer all the other advantages of an R-2000 home.

Dave Read

Dave Read is an energy consultant living in Cranbrook, B.C.

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TESTING AIRTIGHTNESS OF ADA HOUSES

Using an Infra Red Scan to Locate Air Leakage Sites in ADA Houses.

When a blower door test is done, a smoke pencil is typically used to detect air leakage sources. This may not be appropriate for houses employing the airtight drywall approach. The failure of this method to uncover leaks in an ADA house were recently noted in two problem cases in Vancouver.

Locating leaks with a smoke tube can be difficult even for the most experienced airtightness tester. Houses using polyethylene vapour barrier and acoustical sealant approach can be visually inspected or even better, pre-drywall tested by reversing the blower door test. However, ADA houses can only be tested when all finishing work is complete. Consequently, mistakes in building a continuous air barrier in ADA houses are hidden behind drywall and become a mystery.

Infra red scanning equipment combined with a blower door (the Retrotec infiltrometer) was used to expose air leakage paths in two ADA houses.

The two houses were of similar construction and style. One house, in the Vancouver suburb of Coquitlam, was air sealed by a specialized sub-contractor who guaranteed the house would pass the air test. The second house in Vancouver was sealed by the builder's own crew. Both groups were very experienced and never had any major difficulty passing an air test. However, on the first air test both houses measured more than twice the air leakage allowed by the R-2000 Program. Conventional methods of testing houses could not pin-point the major failure in the air barrier.

The builders, homeowners and air sealing crew were frustrated with the failure of the house. The builder and air sealing subcontractor both felt that enough effort, time, and money had been spent. The air leakage sources remained a mystery, and they felt the house should be allowed to pass. On the other hand, the homeowners were determined that the house qualify as an R-2000 home and the builder meet the contractual obligations (which includes passing the air test).

"How much difference could a few square centimeters of leakage make on the comfort or heat loss of the building?" is a question that arises in these cases.

The benefits of a tight envelope are quickly forgotten when houses have difficulty passing a test. It is worthwhile to review these benefits:

1) Prevent dust, spores, noise, and insects from entering the house.

2) Prevent interior air from carrying moisture into wall and ceiling cavities where it can cause moisture decay.

3) Give the occupant the ability to filter air, heat and cool air, and ventilate the house for maximum comfort.

The benefits of structural integrity, pollution control, and environmental comfort are obtained by employing the most advanced building technology. At some point, unknown to us all, a house crosses a threshold of airtightness where these benefits are achieved. It is better to err on the too tight side than compromise all of these benefits, especially when it only costs about $800 to have a specialized subtrade make the envelope of a house airtight. (This may represent only 1% or so of the total construction costs).

There is much pressure to bend the rules. Emotional pressure, money and effort expended, or the fact that thousands of dollars are being withheld by the homeowner does not justify making exceptions for a house that does not meet the air tightness test.

Builders who have had to meet the test in the past and homeowners who are paying for the R-2000 product demand equal treatment. The air leakage test must treat all houses and builders impartially and fairly. Making an exception for a house erodes the credibility of the R-2000 performance standard.

It must be remembered that <u>all</u> houses built by R-2000 builders cannot be expected to pass the air test. During my years of air testing I have had two houses fail because the builder used new techniques for air sealing. In one case the builder used drywall glue to seal drywall to the bottom and top plates. However, the glue cracked when the house settled. In another case a builder had relied on a pre-fabricated wall system to provide the air barrier. It was impossible to economically air seal the houses after the fact.

To solve the mystery of the Vancouver and Coquitlam houses that could not meet the test, infra red scanning equipment was employed. Bruce Whiting (of Infra-View Energy Analysis, an experienced technician who has done hundreds of insulation scans on houses) was employed. Testing an R-2000 house that failed to meet the air test was a new experience for him.

The first scan was done walking through the house while the blower door depressurized the house to 50 pascals. As cold air was forced into the house through leaks, it appeared as dark patches with feathered edges on the video screen. Another scan was done from outside the house with the blower door reversed and the house pressurized. Warm air was forced out of the house through the leaks, where it appeared as white patches with feathered edges on the screen. The infra red scan exposed air leakage paths by detecting the heating and cooling affects of air leakage.

The infra red scan of the Vancouver house showed air leakage in the following areas:

1) interior and exterior wall joints. The drywallers had not screwed to gasketed studs, so the bowing out of drywall left a ¼" by 8' gap in 10 or more locations.

2) between floor joist blocking against the exterior wall in kitchen and dining room area

3) numerous small leaks

The house met the R-2000 airtightness requirement after one day of sealing the areas located by the scan. Some drywall was removed to assist the sealing process and then replaced.

The infra red scan of the Coquitlam house showed air leakage in the following areas:

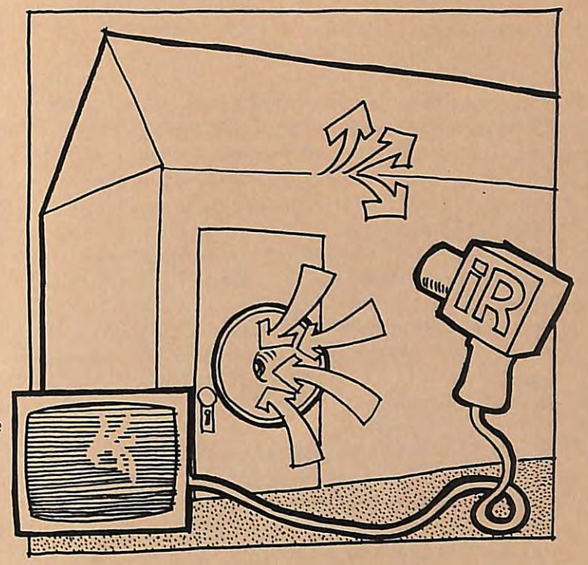
1) joist area between the main floor and the second floor where a range hood fan duct ran to the outside.

2) a zero clearance fireplace that did not have a drywall surround and did not have the recirculating air ducts installed properly.

3) leakage into forced air ducts running along the surface of the house envelope.

4) numerous small leaks.

The house met the airtightness standard after sealing the leaks and installing an



induced draft fan on gas appliances (so an extremely leaky outside furnace room could be included in the envelope).

Both the builder of the Vancouver house and the air sealing sub-contractor of the Coquitlam house were impressed with the results of the infra red scan combined with the blower door test. They both would not hesitate to have a scan at the first sign of difficulty in passing the air test. This experience underlines the importance of doing ADA correctly the first time - or there may not be a second chance!

Peter Moffat is director of the Testing Division of Sheltair Scientific Ltd., a Vancouver based building research and consulting firm.

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85 CODE HOUSES: HOW TIGHT ARE THEY?

The latest edition of the code has incorporated requirements for air sealing. Some builders consider it is an imposition of R-2000 Standards on mainstream building activity (this was not the intent). But just how tight are houses built under these new code provisions? It is important to know, as it will be relevant to how ventilation and combustion appliances in the house will perform. To find out what is happening in the field, several houses in Delta (a Vancouver suburb) were air tested.

Houses were tested in two different modes: the first had all intentional holes sealed; the second had all intentional holes unsealed.

What was found?

The tested houses measured in the range of 5 to 6 Air Changes per hour at 50 Pascals. The total equivalent leakage areas were in the 1000 cm^2 range. (Intentional holes usually totaled up to 200 cm^2).

What does this mean?

Typical new construction in the area prior to the enforcement of the 1985 Building Code would have measured anywhere between 7 and 12 Air Changes per hour. The Lower Mainland of B.C. has the leakiest houses in Canada; houses in the Winnipeg area prior to code changes would have been in the 4 to 5 Air Changes per hour range. (Winnipeg generally has the tightest construction practices in Canada).

Where is the Leakage?

Leakage of conventional houses usually breaks down into these four broad categories:

25% Joist trimmers (joists ends)
25% Windows and doors
25% Attic penetrations
25% Miscellaneous

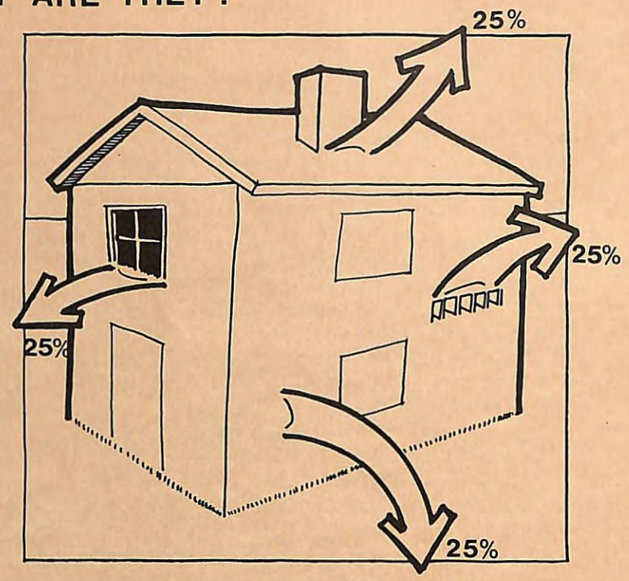
What does this mean?

I suspect that the relatively small decrease in air leakage is due to the following reasons:

1) Crews doing the sealing work are neither trained nor experienced

2) Major leakage areas such as joist headers and under bottom plates of walls are not being sealed. Only a relatively small portion of the leakage area of the houses is being effected by sealing measures.

3) There is no motivation to tighten the house. Hence the planning and organizing of



sub trades required for achieving a tight house is not being done.

4) With many R-2000 builders having houses come in at over 3 air changes per hour on the first test, the difficulty of sealing houses is underestimated.

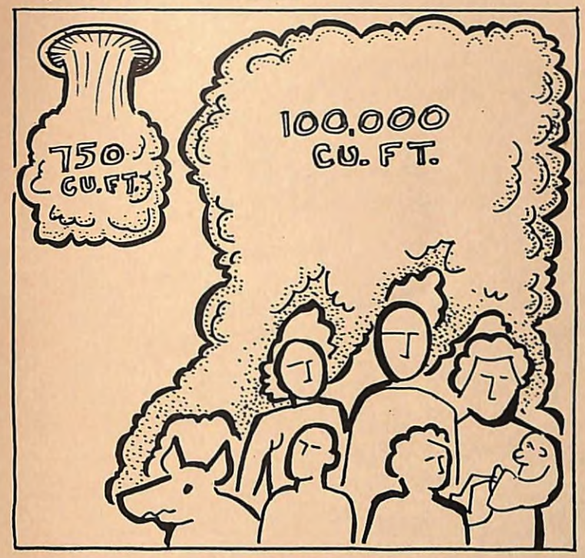
However, the potential for backdrafting of combustion appliances may have increased with this change in air tightness. B.C. houses generally have a large number of fans and fireplaces and outdoor temperatures are much warmer in the winter than in other parts of the country. As a result, stack action (and passive ventilation) do not develop high enough pressures so there is an increased likelihood of B.C. houses experiencing backdrafting problems.

For a house with a 1000 cm^2 leakage area it only takes 140 L/s (280cfm) to create 5 pascals of house depressurization. At this pressure the typical naturally aspirated gas appliance (such as furnace or hot water tank) will begin to backdraft. Passive air ducts are basically useless for preventing backdrafting as has been demonstrated in previous work by Sheltair Scientific and the Saskatchewan Research council.

There is evidence that houses with strong exhaust fans, such as downdraft cooktops, will experience backdrafting any naturally aspirating appliance when the strong exhaust fan is turned on.

Peter Moffat

VENTILATION: HOW MUCH IS REALLY NEEDED?



There has been considerable debate about how much ventilation is needed. The Code now requires a system capable of providing one half an air change per hour, but there is no requirement that the system run continuously (which is desireable).

Installation of separate bathroom and kitchen fans with a total capacity of .5 ACH will meet the code requirement, whether or not they really provide those air flows.

A 50 cfm fan will likely, at best, provide 25 cfm (the rest being taken up by resistance of ducts, backdraft dampers and insect screens). A bathroom fan may be operated for only an average of 30 minutes per day, thus moving only about 750 cubic feet of air per day.

Internationally, a consensus is emerging that a continuous flow of 15 cfm per person per day (for non-smokers) is needed. This is 21,600 cubic feet per day per person.

Detailed monitoring of a new (R-2000) home in Vancouver, occupied by a 7 person family (2 adults and 5 children aged 1 to 8) has shown that on the average winter day total measured ventilation was 100,000 cubic feet. Indoor conditions maintained 50% relative humidity, CO_2 concentration peaked at 1000 ppm, and acceptable odour conditions. The ventilation rate is equivalent to 0.19 ACH.

The home is a 5 bedroom, 1900 sq.ft., 2 storey house with a partial walk out basement.

B.C. CODE CHANGES VENTILATION REQUIREMENTS

The vague language on residential ventilation requirements in the 1985 edition of the National Building Code has caused much concern, largely due to a lack of understanding of the basic issues, as well as uncertainty on how to ensure compliance. Builders are not sure what do to; building inspectors do not know what to look for. As a consequence, some jurisdictions did not adopt the provisions, others did but were not sure how to interpret it.

In B.C. when the realization sank in that ventilation is a new requirement, pressure arose to remove the offending section. (The "if you don't talk about it, maybe the problem will go away" school of thought.)

Fortunately there is a group of knowledgeable people who were able to work to improve the code language rather than just scrap it. The Technical Committee of the Canadian Homebuilders Association drafted proposed revisions. These are seen as being a bridge to cover the situation until the CSA Standard on Residential Ventilation is ready to be referenced in the code. (A draft is to published later this year).

At publication, it appears that changes will be made to the B.C. Building Code. They are a modification to the CHBA proposals, but should clarify the situation.

In summary, the B.C. code will include:

* Ventilation system capacity to be .3 air changes per hour (ACH) if a distributed system, or .5 ACH if non-distributed. Part of the whole house ventilation (.25 ACH up to 80 cfm) is to be supplied by a low noise fan controlled a by dehumidistat located in a central location.

* The dehumidistat controlled fan must have a maximum noise rating of 60 dBA (or 2.5 sonnes) at the rated air flow. The airflow capacity is to be rated at 50 Pascals (0.2" w.g.). Limits on duct work are proposed.

* Make-up air must be provided unless the dwelling has no combustion appliances or where all combustion appliances are sealed or induced draft (this includes fireplaces). In areas with design temperatures colder than -10°C the make-up air must be tempered.

Tables will provide sizing information for fan sizes (related to floor area), for make-up air duct sizes, and for make-up

requirements for large exhaust fans.

It is anticipated that the changes will be implemented by July 31, 1988 (with a 90 day transition period before the new requirements are mandatory). While the proposed changes don't solve all problems in the present code, they go a long way to clearing up some of the confusion in the existing.

LETTERS TO THE EDITOR

Sir,

After reading J.C. Currie's paper on air tight construction and your response on same, I pose the following question:

I have been led to believe by various governments, (Federal and Local) and by publications, that airtight construction is an integral part of energy efficient construction. It's name implies "saving energy", which is what I thought this entire "can of worms" was about. Why was this subject not broached in 3½ pages?

Fred C. Bartel
BAR-TEL INFRASCAN
Kirkland, WA

Sir

I'm a custom builder in Thunder Bay with a number of R-2000 houses under my belt. We try different ideas to get the best built house which, as you harp, is first a healthy house. I find SOLPLAN REVIEW very informative and helpful. It has verified some of the things we're doing, proven some things we're doing incorrect, and gave us innovative ideas that we've incorporated.

Product, seminar and event information we've found in your pages are also useful.

Sometimes we feel like a fish out of water, and wonder why the hell we bother; just pump them out like everybody else and make some money.

Your magazine stimulates, motivates and keeps my conscience in line. Thanks and keep up the good work.

Brian Seargeant
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LEBCO COMMENTARY

The Heating Refrigeration and Air Conditioning Institute of Canada (HRAI) is fighting proposed legislation of minimum efficiency levels for space and water heating equipment and a labelling program for these products. They say they favour efficient equipment, but suggest the marketplace determine what is manufactured.

The HRAI position was prepared because of proposed legislation by Ontario (where most manufacturers are located). In part, it is a response against likely dumping of inefficient equipment from the US.

United States law now specifies minimum efficiency ratings for heating appliances. (Effective next year, the minimum is 78% for gas furnaces, 80% for gas boilers, 54.4% for 40 gal gas hot water tanks).

We must be concerned for if the Free Trade agreement is implemented, Canada will be flooded with quantities of inefficient equipment: ends of production runs no longer acceptable in the US and runs using old technology (snatching extra profit from old designs). Many American manufacturers are already doing business in Canada, so they have the sales and distribution networks in place.

The marketplace is very cost conscious. Too many go for the lowest first cost, no matter what. The effects of low cost, naturally aspirating appliances in today's homes go beyond energy efficiency. As homes are being built tighter, there is more chance for backdrafting to take place, to create unsafe indoor environments.

HRAI does not support labelling as they say these appliances are not shopped for in the conventional sense. How does HRAI expect the small builder (who builds the majority of housing in Canada) to assess competing products? Most do not have access to engineering expertise to assess competing claims. A labelling program provides the opportunity for the consumer (builder or homeowner) to compare products.

We must not forget that energy conservation is a national interest. HRAI says they favour more efficient equipment, but they do not seem to be doing anything to show a real commitment to improvement. If HRAI were to take action on their own, there would be no need for legislation.

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INCREMENTAL COSTS

Everyone wants to know what the incremental costs are of various energy conservation upgrades. Obviously, costs will depend on home design, location, labour and material costs.

A study of 20 identical houses (1040 sq.ft. bungalows with full basement) built by Flair Homes of Winnipeg in the spring of 1987 provides some information about these costs.

Achieving airtightness is perhaps the most difficult component to cost for most builders. The incremental costs for homes in this project, including completely insulated and sealed basements, were as follows (these are net, over and above standard construction costs):

* Sealed poly air/vapour barrier $260.66
* Airtight drywall (ADA), paint vapour barrier $201.16
* ADA, 4 mil poly vapour barrier $116.55

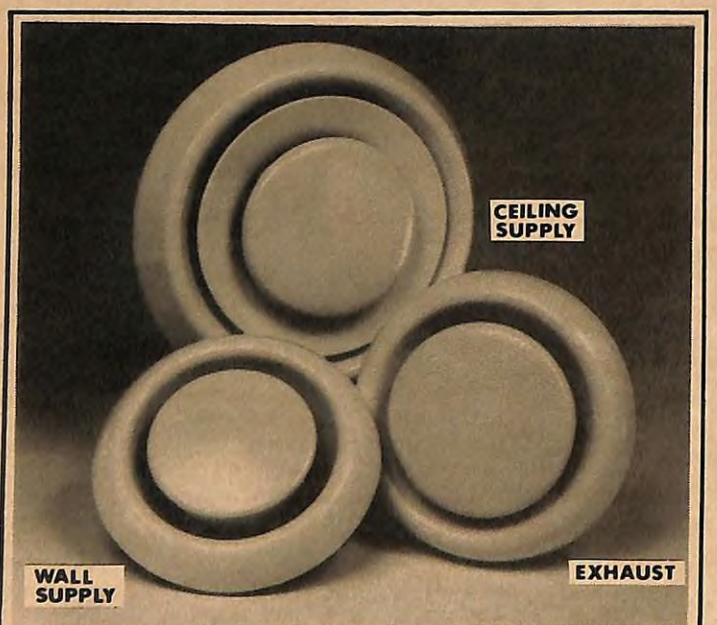
The project has looked at many other costing and performance aspects of home construction. Detailed monitoring is being carried out by Gary Proskiw of Unies Ltd.. We will provide more detail on this project in coming issues.

NEXT

COMING IN FUTURE ISSUES:

* Radon: an update
* Cost analysis of alternate energy efficient techniques
* Residential sprinklers

and more continuing coverage of the latest development in residential building technology, new products, developments, etc..



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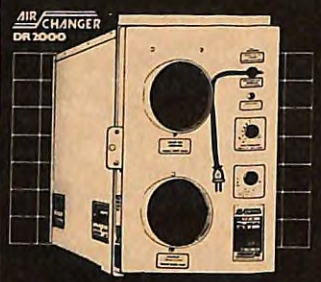

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* According to independent lab testing to CSA standard C439M. For further information, call or write:

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